

507,174

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
25 September 2003 (25.09.2003)

PCT

(10) International Publication Number  
**WO 03/078919 A1**

- (51) International Patent Classification<sup>7</sup>: **F42B 33/02**
- (21) International Application Number: **PCT/GB03/00952**
- (22) International Filing Date: **6 March 2003 (06.03.2003)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:  
0205565.5      11 March 2002 (11.03.2002)      **GB**
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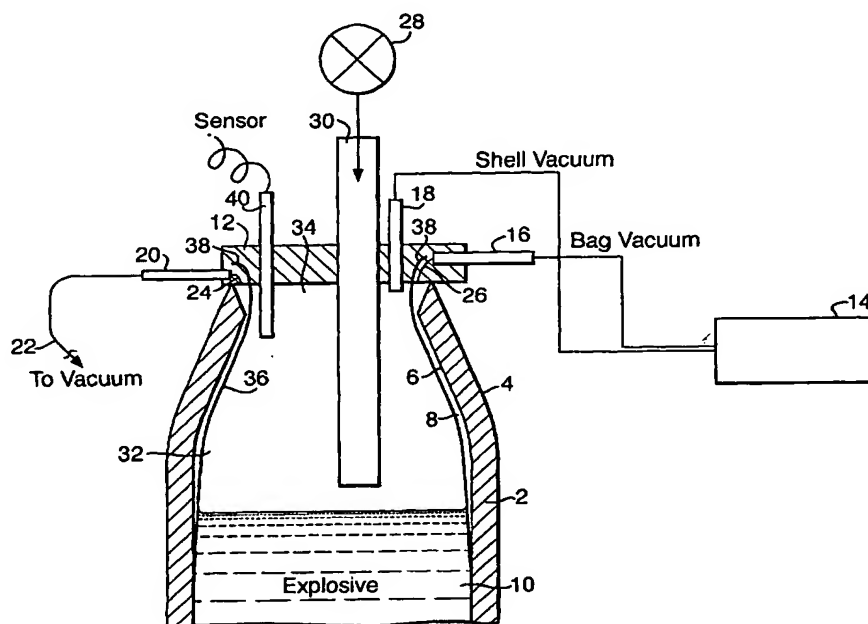
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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: **EXPLOSIVES LINER**



(57) Abstract: Described herein is a method of filling ordnance with explosive materials. An ordnance shell (2) comprises a cavity (32) filled with explosive material (10), the explosive material (10) being contained in a bag (36) located within the cavity (32).



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**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

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### EXPLOSIVES LINER

This invention relates to the field of the filling of ordnance with explosive materials.

Traditional methods used for filling ordnance with polymer bonded explosive (PBX) utilise a filling process based on the combination of usually two materials (an explosive mixture (pre-mix) and a hardener). The two materials are mixed together and injected into the volume reserved for explosive materials usually at the tip of the ordnance.

In a typical application of the mixing and filling process, a pre-mix of explosive is produced and typically mixed with a hardener (i.e. IPDI) the mixture mixed together to produce a combined final explosive material (e.g. PBX).

Ordnance to be filled is typically placed in a vacuum chamber and a filling attachment from the bottom outlet valve of the mixer bowl containing the fully mixed PBX composition is attached to the chamber. Typically, the vacuum chamber will be evacuated to <100 millibars.

The vacuum provides the physical motivation for the fully combined final explosive material to flow into the ordnance. However, the interaction of the combined final explosive material and the inner surface of the volume to be filled can lead to problems in terms of the inadvertent adhesion of the material to the sides of the volume during filling. This introduces the possibility of an imperfect fill of the explosive cavity. An imperfect fill of explosives may result in ordnance failing safety acceptance tests, the ordnance being liable to early detonation due to the movement of explosive material within the ordnance as it is launched.

In addition to the problems associated with the issue of imperfect fill, ordnance can be subject to environmental cycling, including temperature cycling, which can cause the explosive material contained within the ordnance to lose some of its required physical characteristics.

The problems associated with imperfect fill and environmental cycling are known in the art and attempts to solve these problems have been made by

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the use of approaches, such as liners which are sprayed or poured onto the inner surface of the explosives cavity or volume within the ordnance. This liner would in turn adhere to the wall of the explosives volume in an attempt to reduce the effects of explosive adhesion and environmental cycling.

5           However, the problems associated with the state of the art solutions relate to the fact that the liner does indeed adhere to the wall of the explosives volume, and consequently the explosive filling thereby suffers from some of the effects induced by environmental/temperature cycling and physical vibration that would have also been observed had no liner been present.

10           Additionally, when ordnance is required to be disposed of at the end of its service life explosive materials comprising PBX cannot be effectively 'boiled out' as in the case of TNT based explosives, and an expensive decommissioning process has to be put in place requiring the effective cutting in two or more parts of the ordnance, to allow for the extraction of the PBX  
15 explosives which will have adhered to the inner wall of the explosive volume.

          The invention described herein provides for apparatus and a method for reducing the problems associated with the filling of explosives, especially in the case of explosives comprising PBX materials and the like, and for drastically reducing the effects of environmental and temperature cycling on the physical  
20 quality of the explosive filling.

          Additionally the invention described herein provides for an improved method of decommissioning ordnance containing PBX based explosives and the like.

          Accordingly there is provided ordnance comprising a cavity filled with  
25 explosive material, said explosive material being contained in a bag within said cavity.

          In a first preferred embodiment of the invention the bag is made of an elastomeric material.

          Preferably said elastomeric bag will have a volume less than that of the  
30 explosives cavity of said ordnance.

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In a further preferred embodiment of the invention the elastomeric bag will have a volume in the range 5% to 10% less than that of the explosives cavity of said ordnance.

5 Additionally there is provided a method of filling ordnance with explosive materials, comprising the use of a bag in accordance with another aspect of the invention, said bag being inserted into the explosives cavity of said ordnance, said bag then being filled with explosive materials.

10 In a further preferred embodiment of the invention a bag in accordance with the invention is forced against the walls of said explosives volume by the action of a vacuum source.

The invention is now described by way of example only with reference to the following drawing, in which Figure 1 is a diagrammatic representation of an explosives filling bag and ordnance filling apparatus in accordance with the invention.

15 Figure 1 shows a top section of an ordnance shell 2 being filled with explosive material 10, the ordnance having both an outer surface 4 and an inner surface 6, the inner surface describing a cavity 32 for housing explosive material 10.

20 Explosive material 10 enters the cavity 32 via a filling tube 30, the flow of the explosive material into the cavity 32 being controlled by a valve 28.

A vacuum filling attachment 12 is secured over the aperture 34 describing the opening in the cavity 32 such that a substantially airtight seal is produced between the atmosphere and the volume within the cavity 32. Vacuum means 14 is provided, the vacuum means 14 being connected to the filling attachment 12 such that any gas such as air within the cavity 32 can be  
25 partially or wholly evacuated by the action of the vacuum port 18 thereby providing a motivating force for explosive material to flow through the valve 28 when opened, down the filling tube 30 and into the cavity 32.

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Additional vacuum ports 16 and 20 are also shown, the vacuum line shown at 22 shown stopped for illustrative purposes only but actually returning to the vacuum source 14.

5 An elastomeric bag 36 is shown held within the cavity 32 of the ordnance shell 2 by the vacuum filling attachment 12. The main vacuum ports 16 and 20 have corresponding smaller ports to enable a vacuum to be created within the space 8 defined by the bag 36 and the inner wall 6 of the cavity 32. The action of this vacuum in extracting gas such as air from within the cavity 8 provides the force required to hold the bag 36 against the inner wall 6 of the cavity 32  
10 thereby providing a bag lined cavity 32 into which the explosive material 10 can be injected.

The elastomeric bag 36 is between 5% and 10% smaller than the shell cavity 32 to ensure that the explosive material (filling) 10 does not adhere to the inner wall 6 of the ordnance shell 2. The bag 36 also ensures that the filling 10  
15 survives environmental changes without cracking. The bag 36 provides a barrier between the filling 10 and the ordnance shell 2 which stretches and shrinks with the filling 10.

In order to maintain contact between the bag 36 and the inner wall 6 in the presence of the vacuum force generated within the cavity 32 by the vacuum  
20 port 18, there must be a differential in the two vacuums produced in favour of the bag vacuum.

The diagram shows a non-contact level sensor 40 present within the cavity 32, the sensor 40 providing a method of sensing the fill volume of the explosive 10 within the cavity 32. The output from the sensor 40 can be fed  
25 back to a control means for effecting the action of the valve 28 and indeed aspects of the explosives process not shown. The sensor 40 therefore controls the filling height of the explosive material as a non-contact fill-to-level device.

The non-contact level sensor 40 may comprise an optical sensor, a fibre optic sensor, a laser or an LED.

30 The decommissioning of ordnance comprising a bag in accordance with the invention is simplified over the now prior art. The bag can be manufactured

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with an anti-adhesion surface to prevent adhesion between the bag and the inner lining of the cavity. Alternatively, the cavity lining itself can be treated with an anti-adhesion material prior to introducing the bag. When subsequently decommissioning the ordnance, the bag containing the explosives can be removed as a whole (if the ordnance design allows) thereby reducing the exposure of the person decommissioning the ordnance to the explosive material. Where the ordnance design does not allow removal of the bag containing the explosives as a whole (e.g. in the case of artillery shell) then a single transverse cut across the major internal diameter of the ordnance should allow the bag containing the explosives to be easily removed in two parts.

The other advantages of the invention will be readily apparent to those skilled in the art and the substitution of elements for mechanical equivalents and adaptation of the process using different materials and the like should be construed as being comprised within the inventive concept as claimed.

References to ordnance in the above specification and claims shall be construed as non-limiting and in respect of the invention shall include without limitation shells, mortars, rockets, bombs, warheads, projectiles and any other weapons or containers which are required to be filled with a combined explosive mixture.

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CLAIMS

1. Ordnance comprising a cavity filled with explosive materials, said explosives material being contained in a bag within said cavity.
2. Ordnance in accordance with the invention described in claim 1 wherein  
5 the bag is made of an elastomeric material.
3. Ordnance in accordance with the invention described in claim 1 or claim 2 wherein said bag has a volume less than that of the explosives cavity of said ordnance.
4. Ordnance in accordance with the invention described in claims 1 2 or 3,  
10 wherein the bag will has a volume in the range 5% to 10% less than that of the explosives cavity of said ordnance.
5. A method of filling ordnance with explosive materials, comprising the use of a bag in accordance with any of claims 1 to 4 wherein, said bag is inserted into the explosives cavity and filled with explosive materials.
- 15 6. A method of filling ordnance with explosive materials in accordance with claim 5, wherein the bag is forced against the inner walls of the explosives cavity by the action of a vacuum.
7. A method of filling ordnance with explosive materials in accordance with claim 5 or 6 wherein a differential vacuum is produced between the bag  
20 and inner cavity wall and the main explosives cavity.
8. A method of filling ordnance with explosive materials in accordance with claims 5, 6 of 7, further comprising the use of fill-to-level control means utilising at least one fibre optic sensor.
9. Ordnance substantially as hereinbefore described with reference to the  
25 accompanying drawings.



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10. A method of filling ordnance with explosive materials substantially as hereinbefore described with reference to the accompanying drawings.

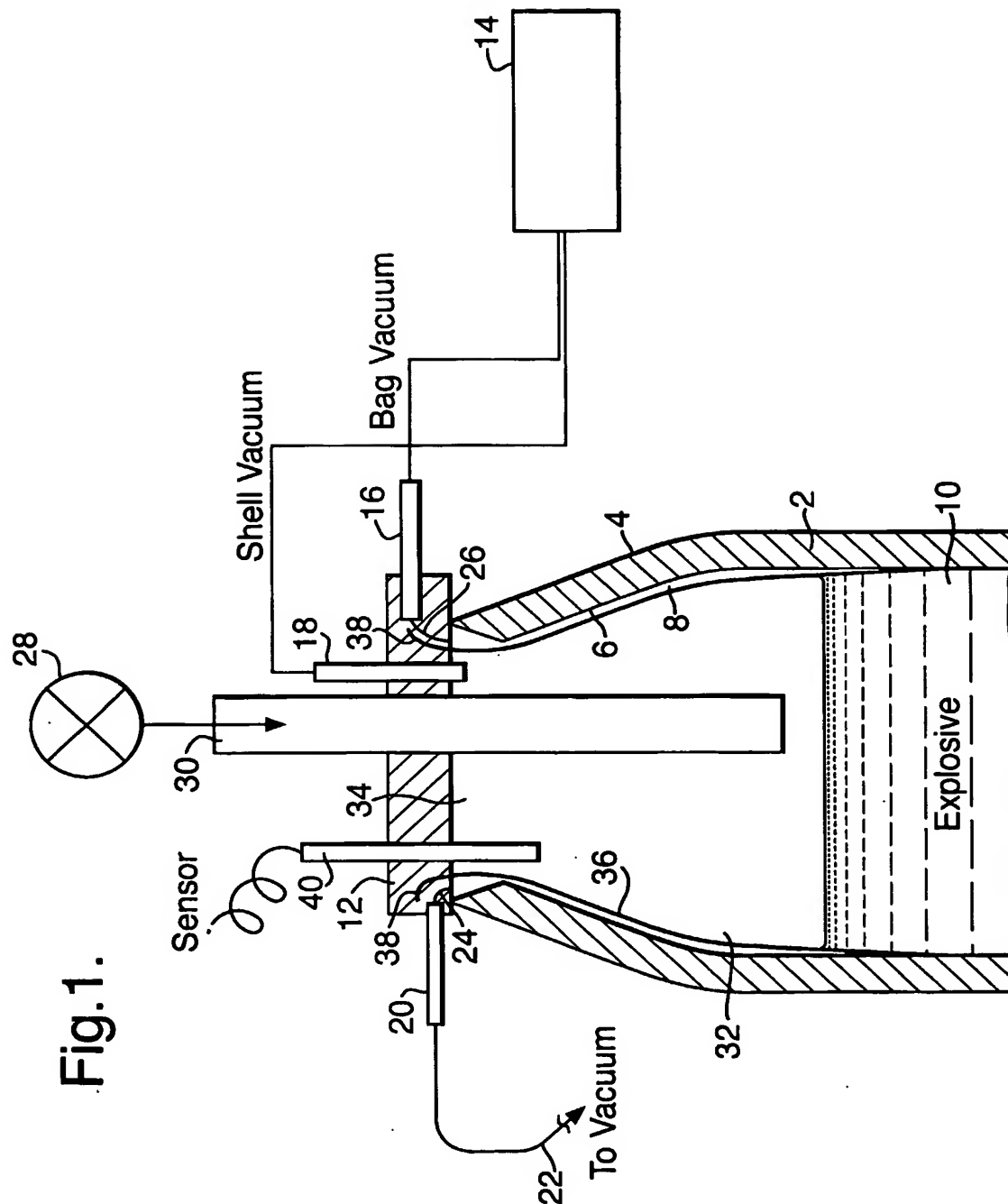


Fig.1.

# INTERNATIONAL SEARCH REPORT

Inter Application No

PCT/GB 03/00952

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F42B33/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F42B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 401 184 A (NOBEL KEMI AB) 5 December 1990 (1990-12-05) column 1, line 50 -column 2, line 25; figures column 3, line 16 - line 34 ----	1,2
A	US 3 646 844 A (CLAY ROBERT B) 7 March 1972 (1972-03-07) column 2, line 46 -column 3, line 19; figures -----	1
A	US 5 353 709 A (ELLER RALPH ET AL) 11 October 1994 (1994-10-11) the whole document -----	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the International filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the International search

2 May 2003

Date of mailing of the international search report

14/05/2003

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Authorized officer

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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/GB 03/00952

## Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 9, 10  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this International application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 9,10

The reference of claims 9 and 10 to the description and the drawings render the scope of the claimed subject matter so undefined and unclear that no meaningful search is possible for said claims.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 03/00952

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